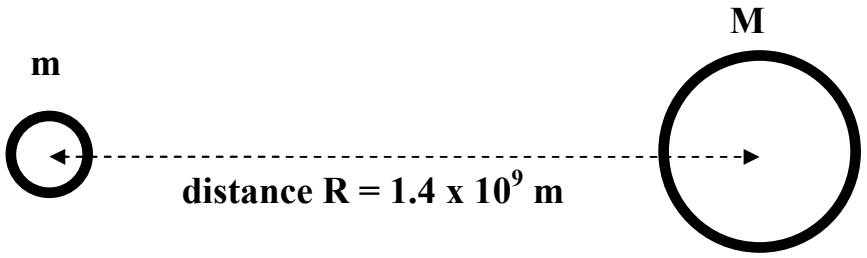
Example 5: Examine this two-planet situation:



$F_g = 4.1 \times 10^{21}$ N

The above is now changed, as follows; find the new gravitational force in each case:

(a) m is tripled.
(b) M is tripled, and m is reduced by half.
(c) M is one-tenth as large, and R is tripled.
(d) m is quadrupled, and R = 9.5 x 10^8 m.

a) $F \propto m$ so $F_{new} = F_{old} \times \left[\frac{m_{new}}{m_{old}}\right]$

$F_{new} = 4.1 \times 10^{21} \left(\frac{3m}{m}\right)$

$\boxed{F_{new} = 1.2 \times 10^{22}\ N}$

b) $F \propto M$, $F \propto m$

so $F_{new} = F_{old} \times \left[\frac{M_{new}}{M_{old}}\right] \times \left[\frac{m_{new}}{m_{old}}\right]$

$F_{new} = 4.1 \times 10^{21} \left(\frac{3M}{M}\right) \times \left(\frac{.5m}{m}\right)$

$\boxed{F_{new} = 6.2 \times 10^{21}\ N}$

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c) $F \propto M$, $F \propto \frac{1}{r^2}$

so $F_{new} = F_{old}\left[\frac{M_{new}}{M_{old}}\right]\left[\frac{r_{old}^2}{r_{new}^2}\right]$

NOTE!

$= 4.1\times10^{21}\left[\frac{.1M}{M}\right]\left[\frac{r^2}{(3r)^2}\right]$

$= 4.1\times10^{21}\left[.1\right]\left[\frac{1}{9}\right]$

$\boxed{F_{new} = 4.6\times10^{19}\ N}$

d) $F_{new} = 4.1\times10^{21}\left[\frac{4\pi}{\pi}\right]\left[\frac{(1.4\times10^{9})^2}{(9.5\times10^{8})^2}\right]$

$\boxed{F_{new} = 3.6\times10^{22}\ N}$